

Cryospheric Applications of Landsat-8

Global ice flow mapping

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Feature tracking of ice flow

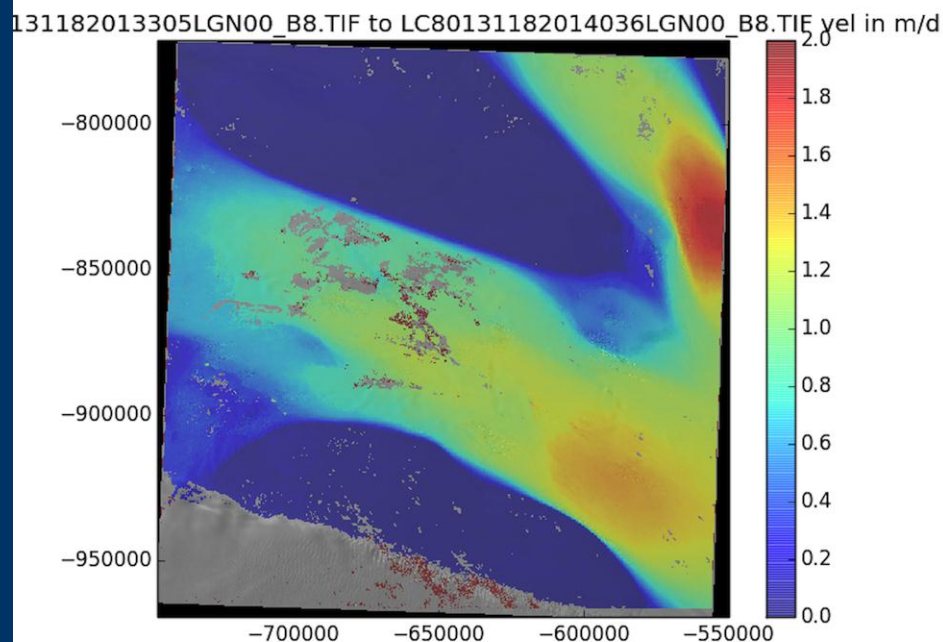
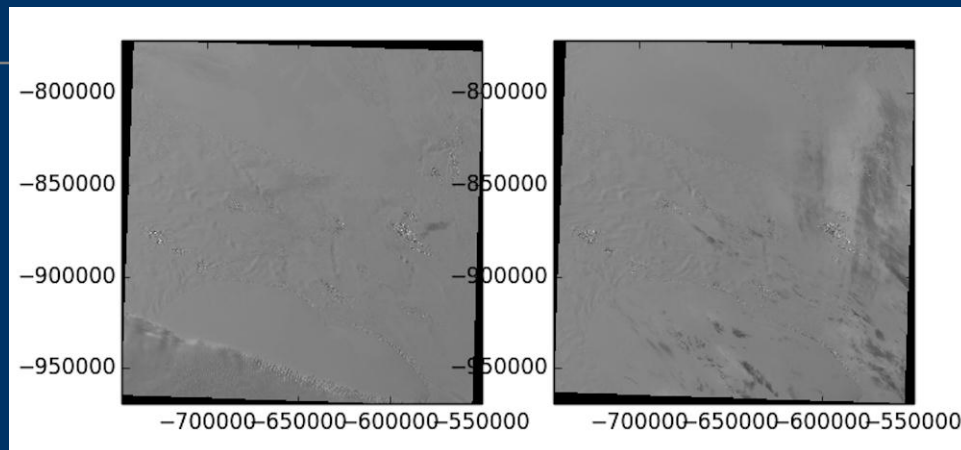
New code makes use of higher radiometric fidelity of L8, and illustrates the high precision of L8 scene geolocation;

Image-to-image cross-correlation applied to ice motion –
Bindschadler and Scambos, 1991;
Scambos et al., 1992;
Fahnestock et al. 1993

Image pair resolves ice motion to 0.3 pixels displacement, or about 5 meters motion;

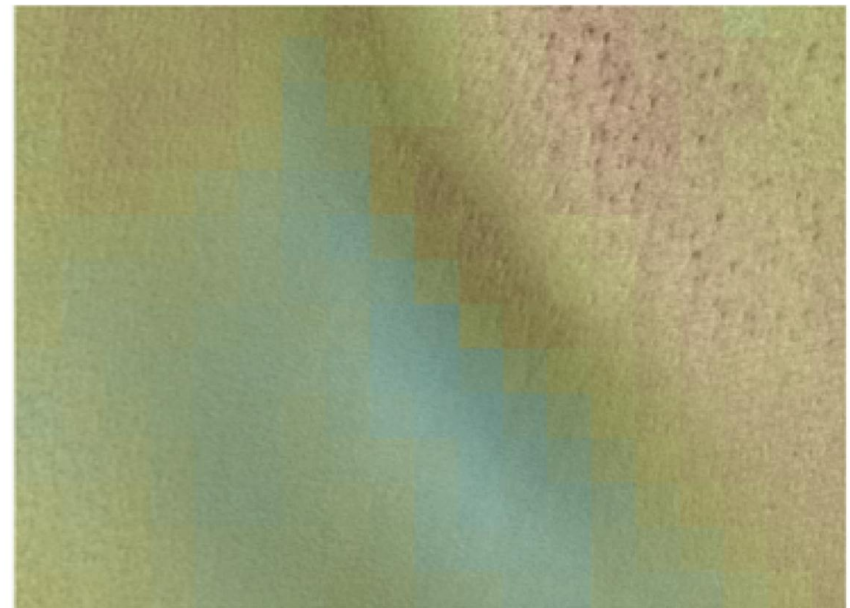
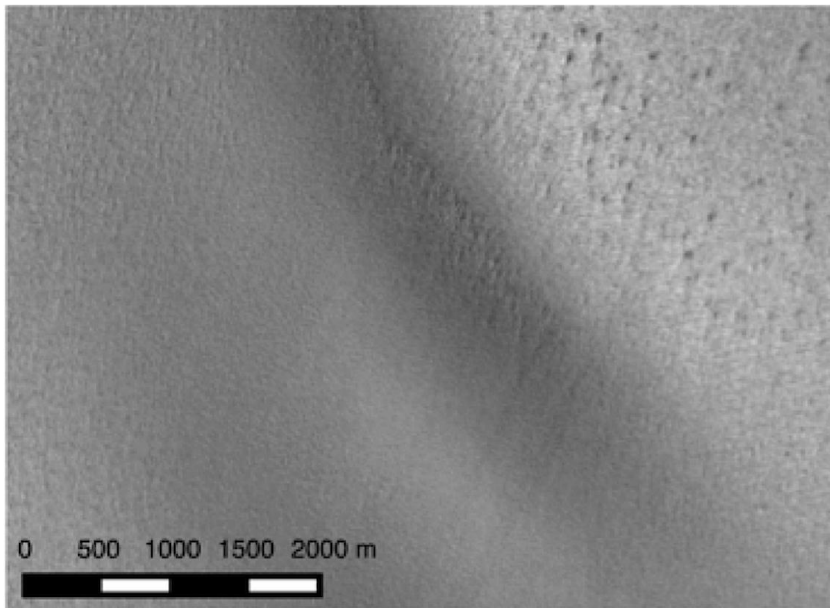
Implied geolocation accuracy in this case is ~2-3 meters.

Software name: **PyCorr** –
Python Image Correlation Engine.



L8 global ice mapping

Enabled by – Radiometric resolution

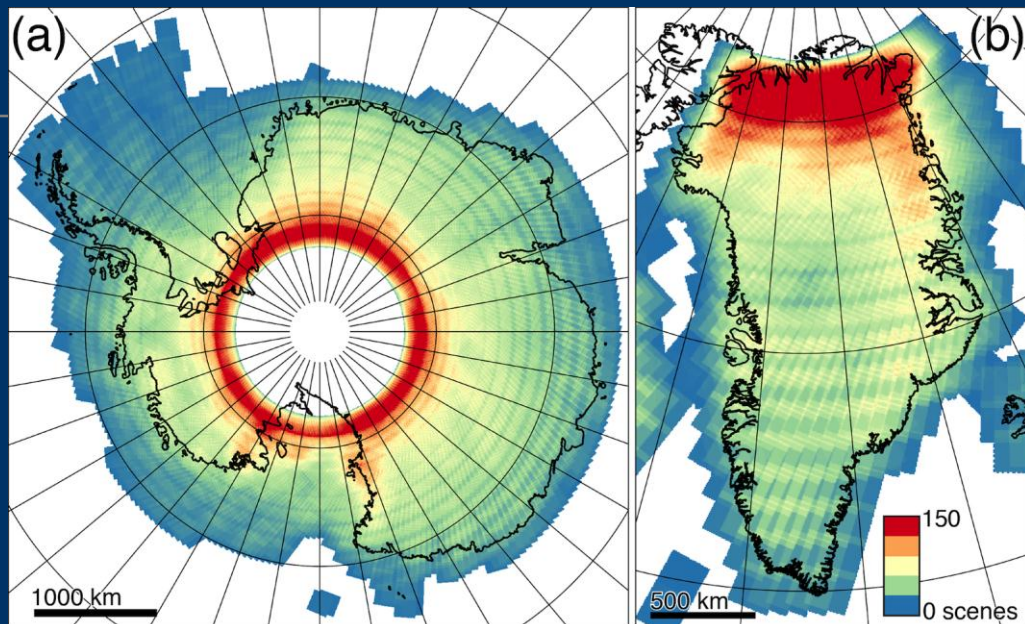


Correlation of subscene image pair
in East Antarctic interior (blue, low; red, high)

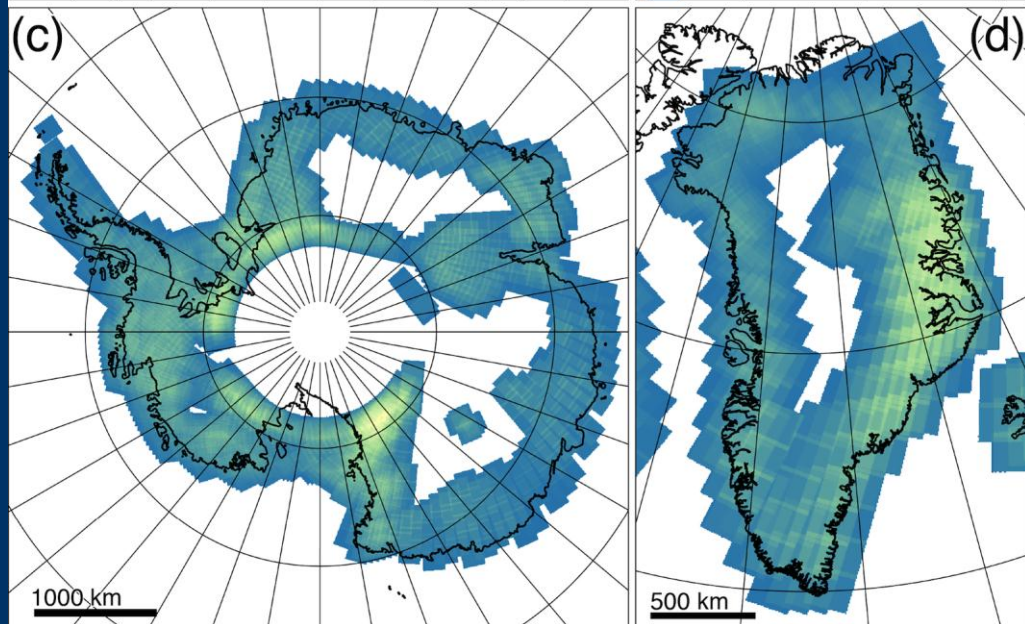
L8 global ice mapping

Enabled by better
acquisition rate.

Landsat 8, 2013-14

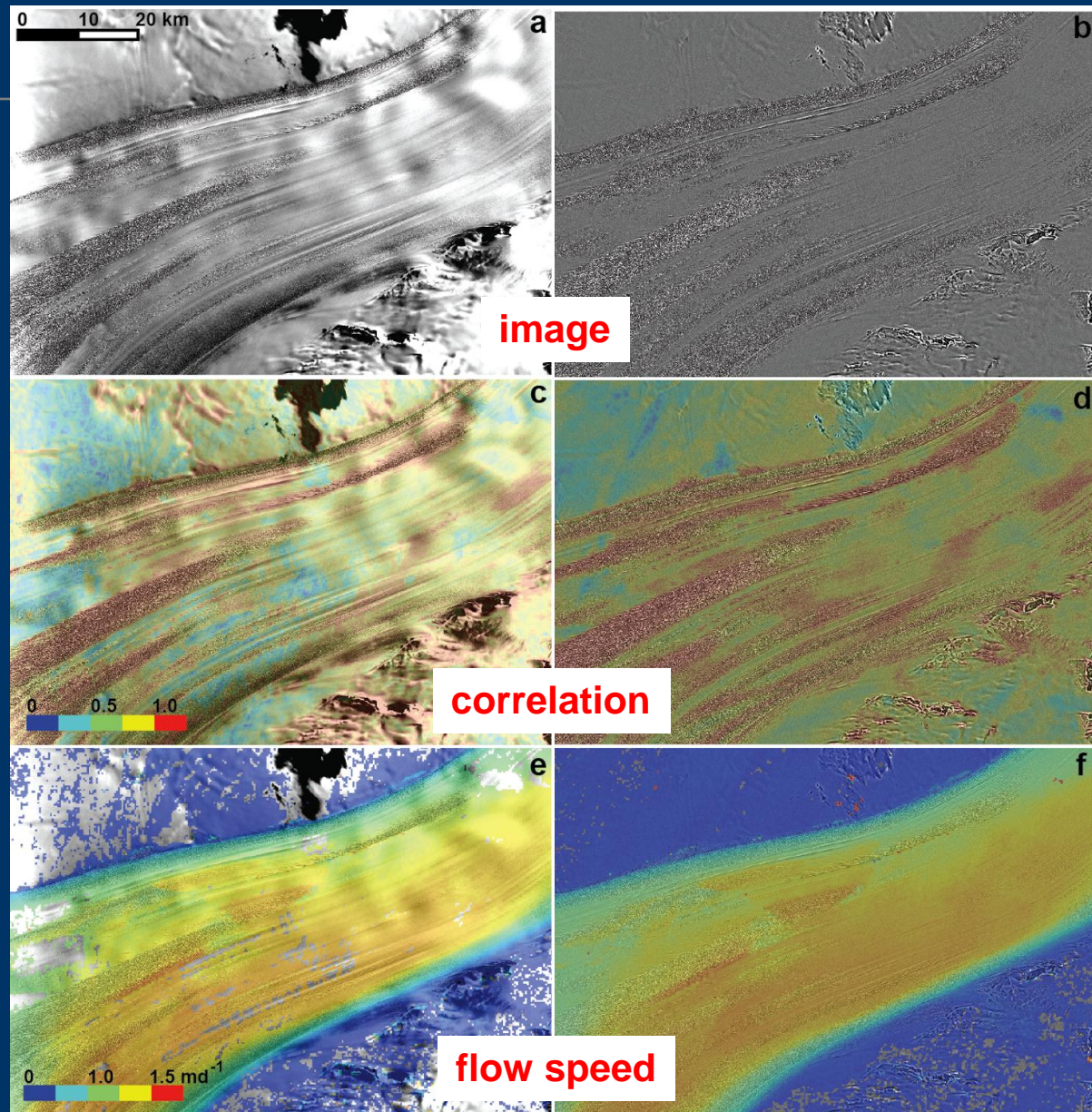


Landsat 7, 2012-13

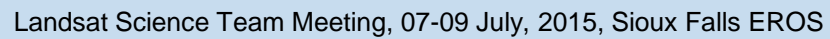


L8 global ice mapping

High-pass filtering improves the extent of successful small-scale feature matches

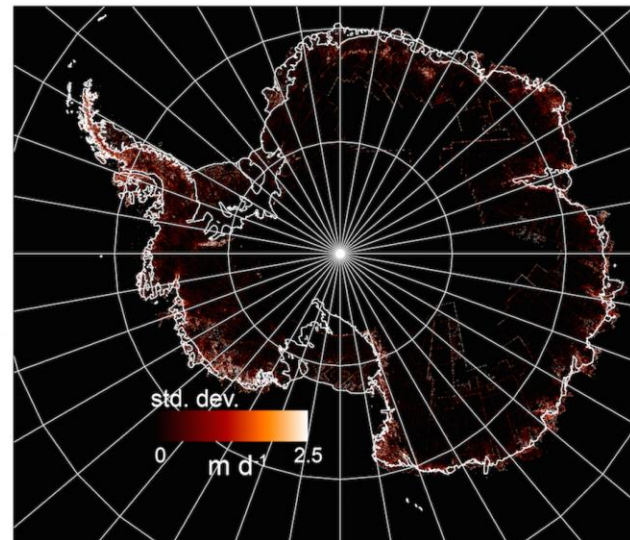
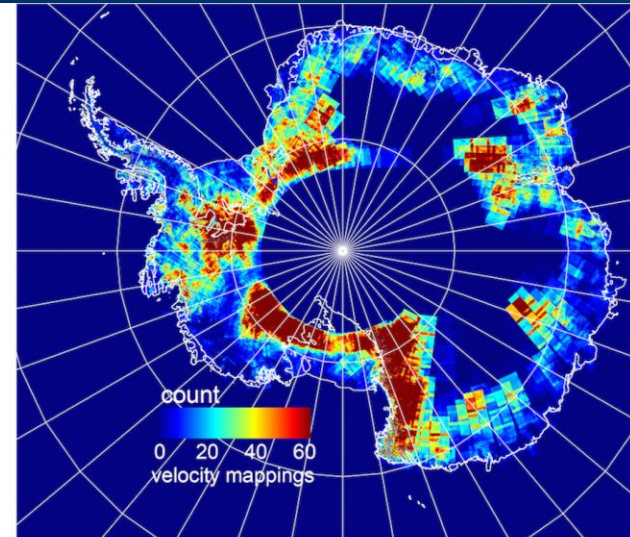
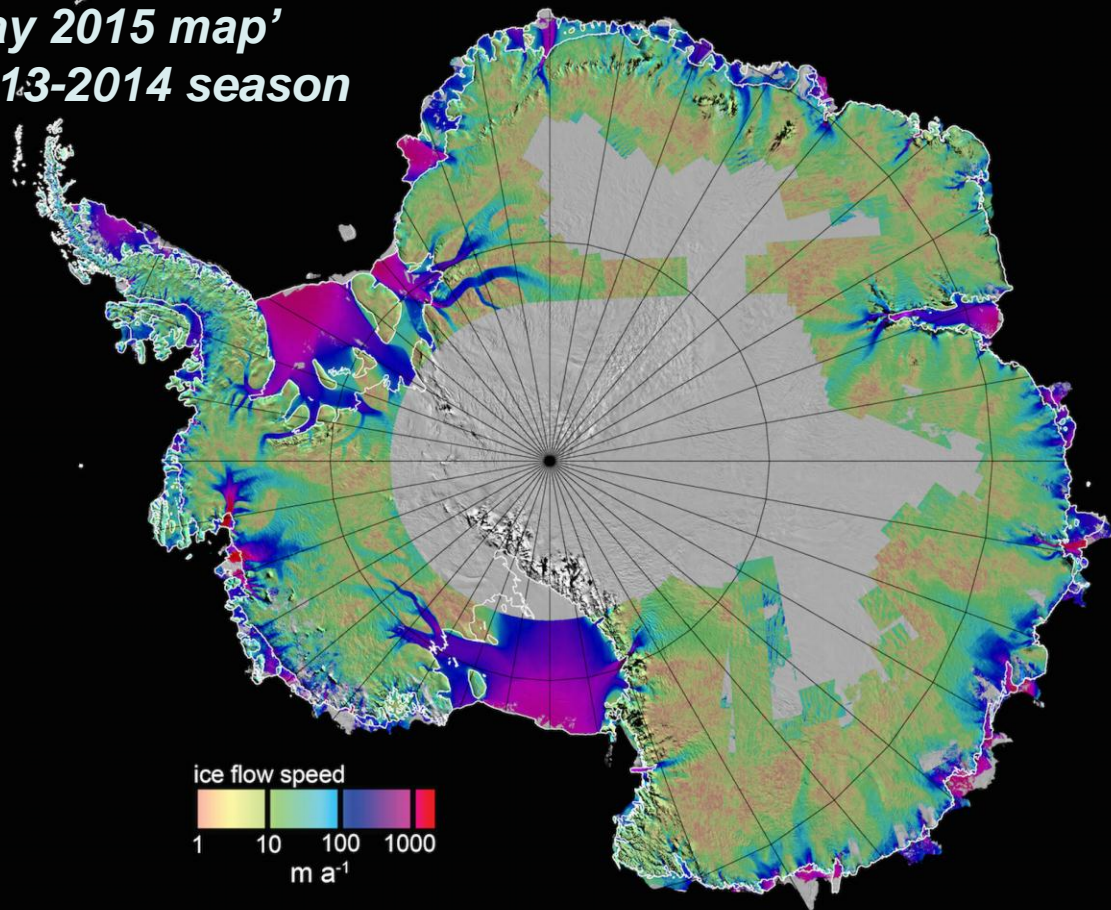


Dec 2014 map,
2013-2014 season

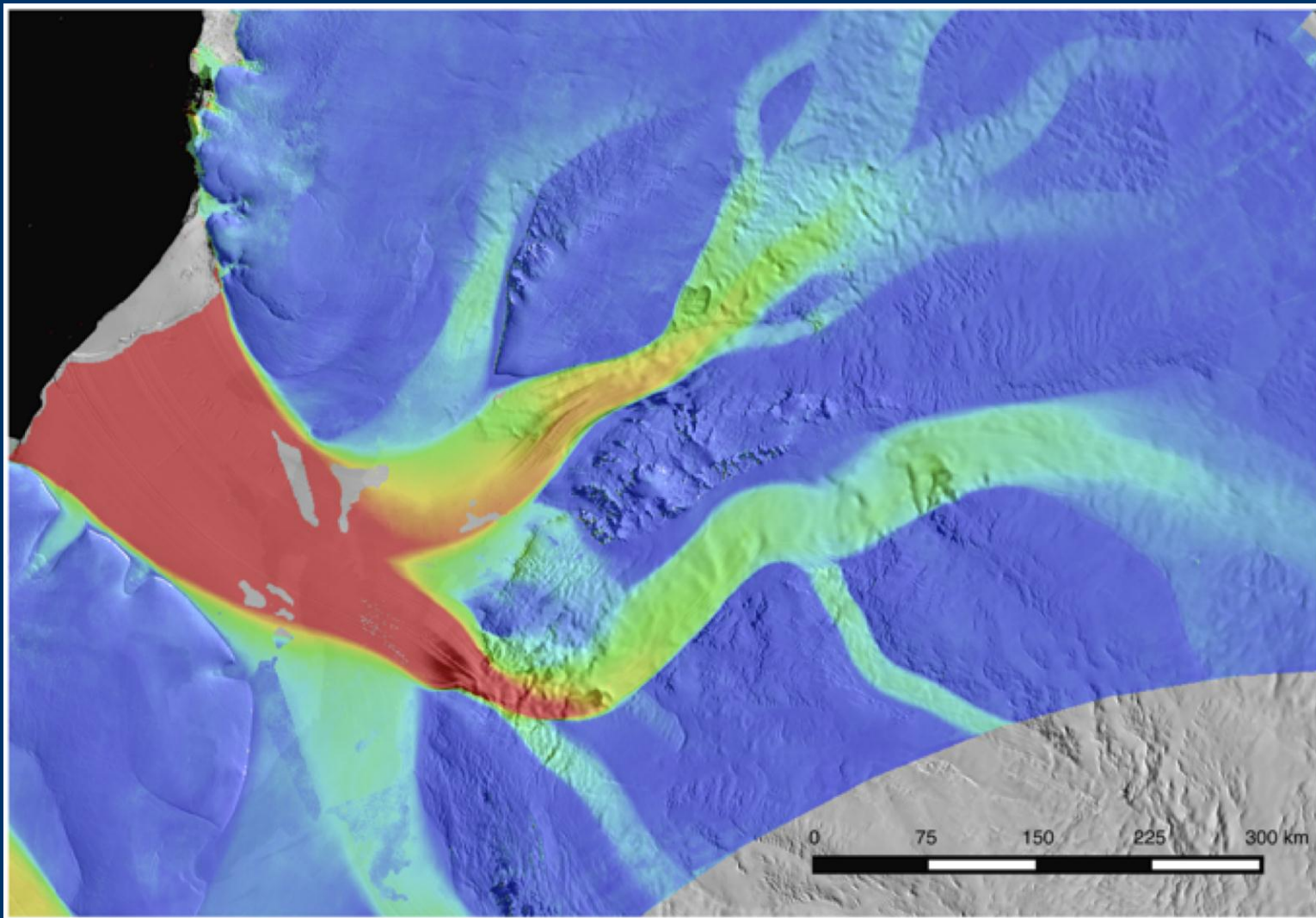


Now....

May 2015 map'
2013-2014 season

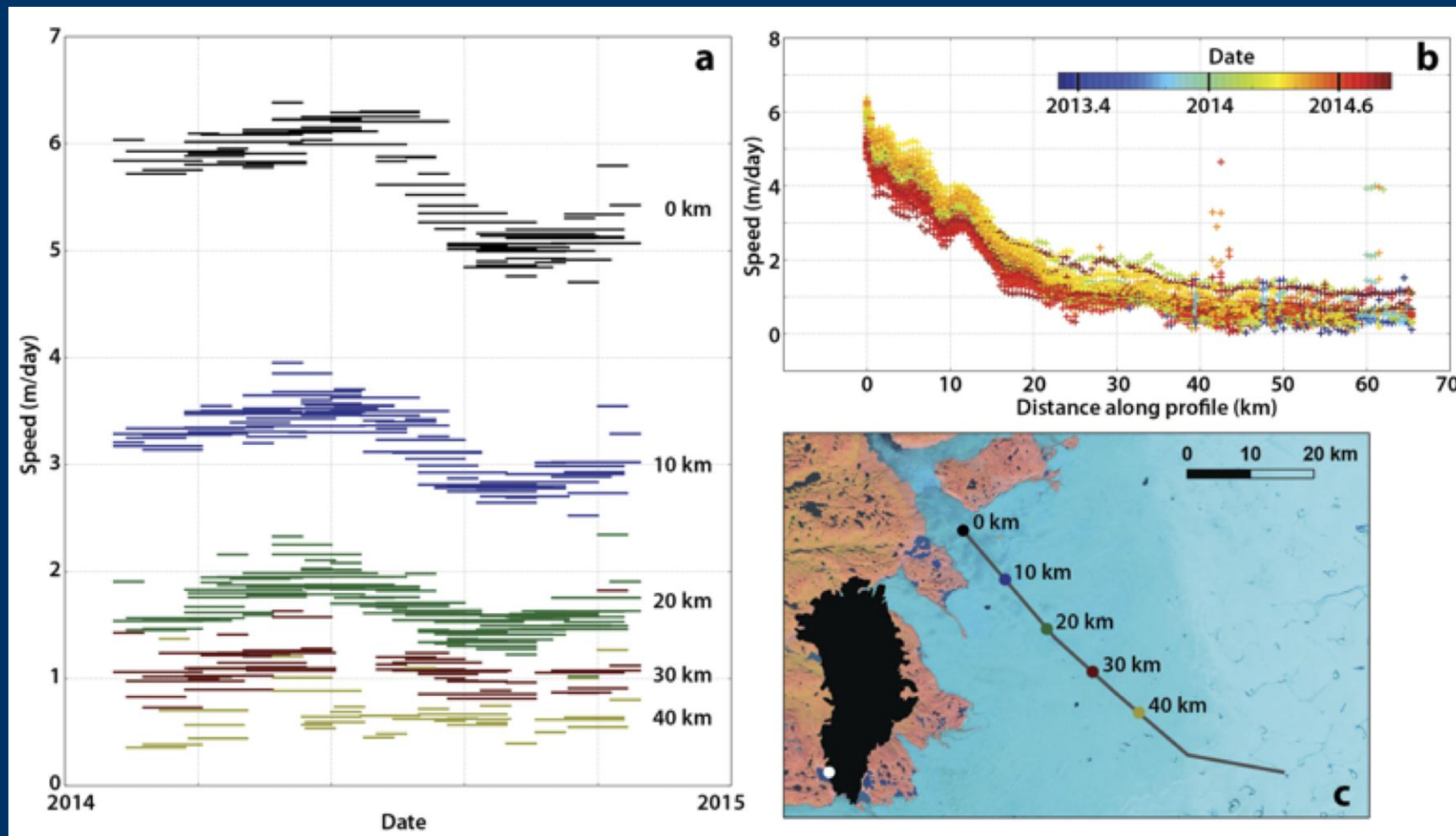


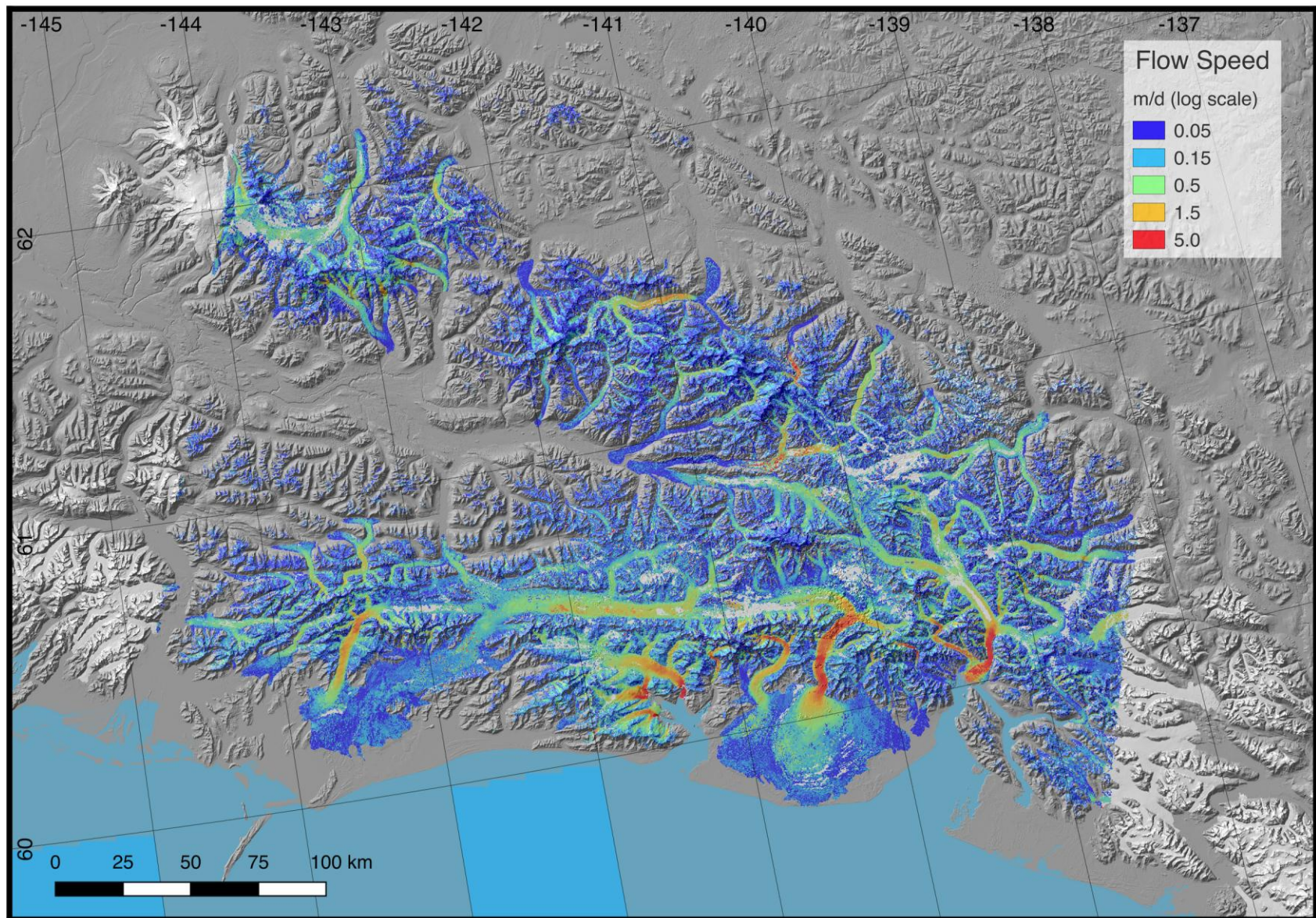
Now.... Slessor / Recovery / Filchner glacier and ice shelf area



Vastly improved ability to detect seasonal changes in ice flow

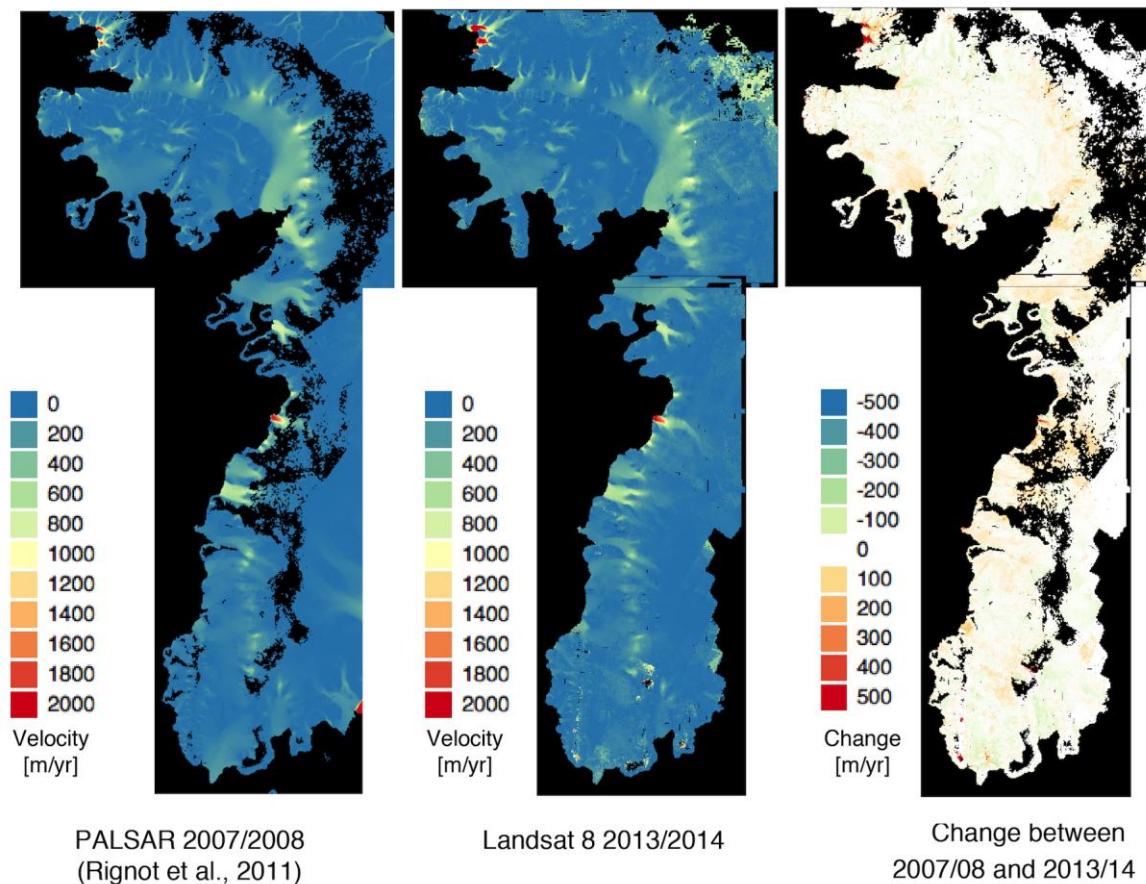
'KNS' Glacier, southwest Greenland - late spring speed-up, late summer slowdown





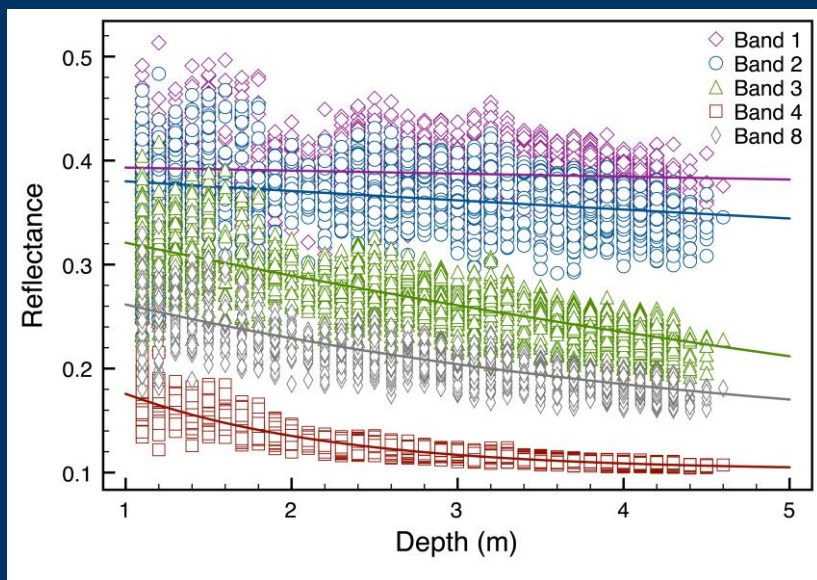
Mapping interannual velocity change in Antarctica

2007/08 vs 2013/14 surface velocities for Palmer Land and Ellsworth Land

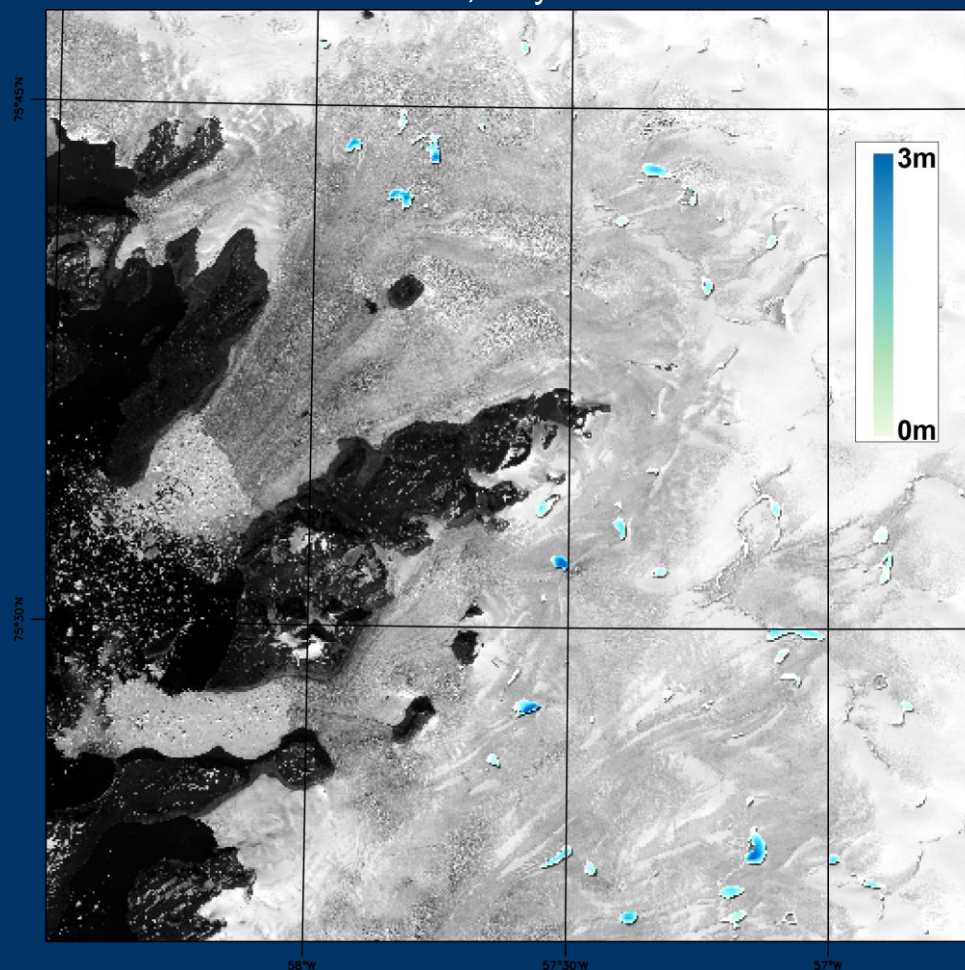


Melt lake depth mapping using Landsat 8

Field data emulation of OLI bands:



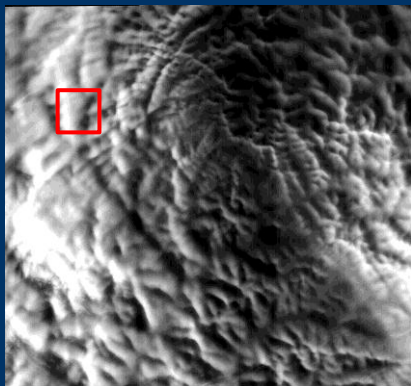
northwestern Greenland, July 18 2013



Two approaches:

- extinction in single band (gr, B3, pan band, B8)
- band ratio (coastal, B1, and green, B3)

Thermal mapping of the East Antarctic interior in winter



Pushbroom sensor noise in thermal channels at low T is significant;
Destriping filter scheme used to extract noise semi-quantitatively

Path 094, Row 120, 02 June 2013;
near Dome A, Kunlun Station, Antarctica

GGC Sun Oct 27 20:38:00 MDT 2013 Raw.153.B10

Original sub-scene

GGC Sun Oct 27 20:35:36 MDT 2013 NA=19 NB=17 NC=101 153.B10

Extracted noise

Std dev 1.7 K

101 x 17 x 19 filter kernels

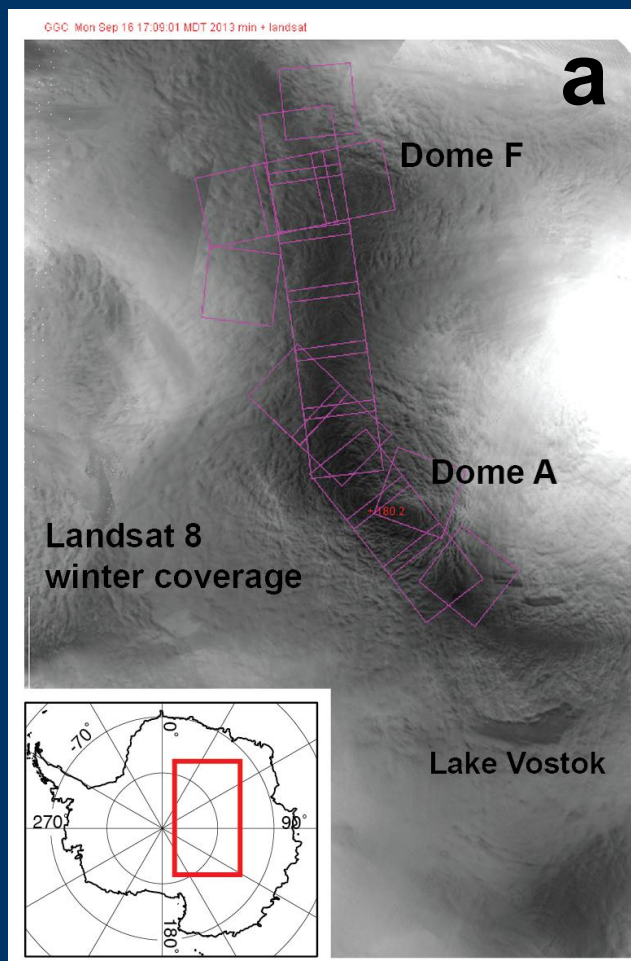
GGC Sun Oct 27 20:36:49 MDT 2013 NA=19 NB=17 NC=101 153.B10

Noise-reduced scene

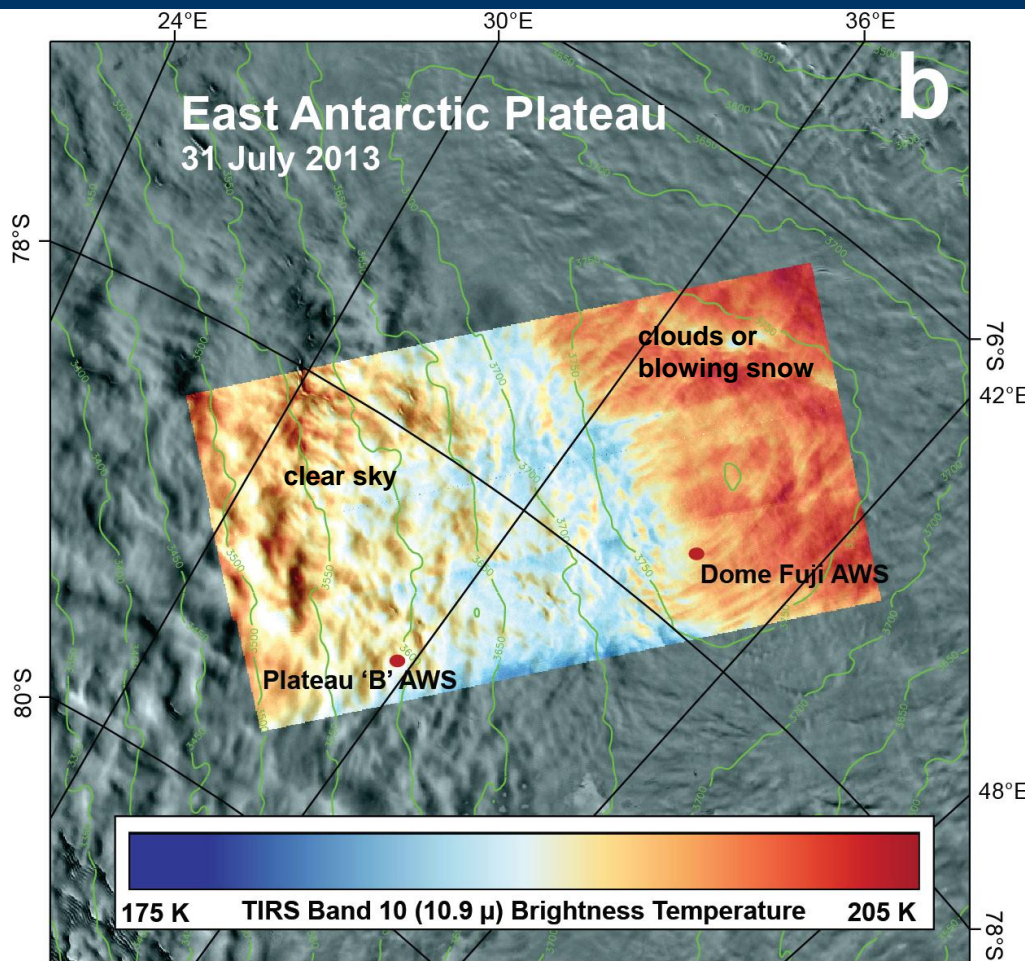
Crippen, PE&RS 1989 filtering (modified)

Thermal mapping of the East Antarctic interior in winter

MODIS LST minimum T, 2013



surface image with Landsat 8 B10 color scale BT



Purple outlines are Landsat 8 acquisitions June-August 2013

Landsat-8 Cryosphere group

- **Ted Scambos** (PI) is a **Senior Research Scientist at NSIDC, a part of University of Colorado**; ice sheet mapping, polar field geophysics, climate change in polar regions, sea ice processes
- **Allen Pope**, **post-doc now at NSIDC**; spectral mapping of mountain glaciers; polar remote sensing
- **Terry Haran**, senior programmer and geospatial mapping, NSIDC
- **Marin Klinger**, data analyst VELMAP processing
- **Mark Fahnestock**, Research Professor, UAFairbanks
- **Alex Gardner**, Research Scientist, JPL/NASA
- **Robert Bindshadler** (**Co-I, contractor**) is an **emeritus scientist for NASA** affiliated with the Cryospheric Sciences group at GSFC

An aerial photograph of a massive glacier flowing through a series of rugged, snow-covered mountain peaks. The glacier's surface is marked by numerous longitudinal stripes of dark rock and sediment. The surrounding mountains are steep and partially covered in snow and ice, with some rocky outcrops visible. The sky is a pale, clear blue.

Main Goals

Promote use of Landsat-8 by the polar and glacier communities

Acquire data that supports wide range of science applications

Conduct a series of key studies, validate new and existing algorithms

Demonstrate effectiveness of the Landsat-8 sensors

Questions?



Potential LDCM studies

Snow grain size and blue ice extent on ice sheets from LIMA / MOA

Morphology of ice sheets and ice shelves
(comparison of 'sensitivity' to past sensors)

Feature tracking w/ Landsat legacy comparison

Lake extent, depth, and volume in western Greenland / AP

Image differencing and sub-ice-sheet water movement

Photoclinometry / shape-from-shading at grounding line and
interior undulation

Thermal mapping of polar ice sheets, winter inversion layer,
ocean SST at the ice fronts.

Acquisition scheme for ice and glaciers

Current acquisition format is all land areas, varying priorities;

- polar coverage is very frequent due to convergence;
- special requests from PIs or users will be considered;
- end *‘one clear, then next year’* Arctic acquisition plan

Planned ~annual special requests:

Antarctic ascending-node coverage along coast –

Greenland ascending-node coverage along coast –

supporting ice velocity and elevation mapping

Sea ice study area north of Alaska and Canada (2 areas)

New targets for thermal channel (polar night, ascending node):

permafrost, debris-covered glaciers, ice sheet coastlines,
Antarctic winter target for extreme low temperatures.